

*Replication of***< Insert Title of Original Study >***by* < Insert Names of original authors in Kedron, P.J. format >*in:* Journal, Volume(Issue), pages**Created**

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<sup>1</sup>Arizona State University, School of Geographical Sciences and Urban Planning, Tempe, AZ, USA– <sup>2</sup>Arizona State University, Spatial Analysis Research Center (SPARC), Tempe, AZ, USA –<sup>3</sup>Middlebury College, Department of Geography, Middlebury, VT, USA*Replication Materials Available at:***Pre-registered Plan** – < URL to access pre-registered protocols >**Data** – < URL to access data, or procedure to access data >**Code** – < URL to access code, or procedure to access code >**Abstract**

Briefly describe the original analysis – type of study, research design, analytical approach, and results; motivation of the replication; and outline of the replication study

**Research Hypotheses to Replicate**

**H1:** Separately list each research question and associated hypotheses being replicated. If a hypothesis is directional, state the direction. Identify the spatial coverage over which each hypothesis is expected to hold, and the spatial coverage at which each hypothesis will be tested (e.g., within a specific sub-region).

**Original test:** Briefly summarize the primary method/statistic used to test the hypothesis

## Original Study Information

**Description:** Present a short narrative that summarizes key information about the original study. Include information about all of the following

1. Provide a written description of the study location and extent. Whenever possible, provide specific geographic coordinates bounding the study extent or a spatial reference file.
2. Identify and describe the spatial support (spatial resolution, unit of analysis) of the original analysis was conducted
3. What type of sample/data did the original study use?
4. Are the data and code used in the original analysis available/used in this replication?

**Analytical Plan:** Describe all elements of the analytical plan of the original study that are relevant to the research questions and hypotheses being re-examined by the replication. Include information for each of the following sub-sections as appropriate.

**Sampling Plan and Data Description:** Describe the data used in the original study. If sampling was used, provide details about the sampling design and how it was implemented.

1. Describe how sampled data relevant to the hypotheses being re-examined was collected by the original authors.
  - a. For human subjects research, include the population from which subjects were sampled, location of sampling, recruitment details, payments for participation, eligibility criteria (e.g. inclusion and exclusion rules), and sampling timeline.
  - b. For research that did not involve human subjects, include information about sample collection, duration of data gathering efforts, source or location of samples
  - c. For studies in which sample location is obfuscated, explain the motivation for the obfuscation and identify the type of geographic masking technique that was used.
2. Describe the spatial sampling design used during data collection
  - a. Identify the design of the spatial sample (e.g., stratified random sample)
  - b. Identify the size of the sample, and how many observations will be collected in different geographic strata or levels if using a stratified, clustered, or multilevel design.
  - c. If a termination rule was used, identify the relevant criteria, original authors' motivation, and how the rule was implemented.
3. Describe any secondary dataset(s), or sub-set(s) of those datasets, used in the original study.
  - a. Explain how the data was acquired by the original authors including – source (with DOI if possible), data of access
  - b. If selected datasets or sub-sets cover only portions of the overall study area or study period, clearly identify which datasets are associated with which locations and times.
  - c. Explain how the data was acquired by the original authors including – source, data of access
4. Describe if/how the original study excluded or adjusted the initial dataset
  - a. Identify any data that was excluded from the original analysis report –reason for exclusion, exclusion criteria, sample size before and after exclusion, location of excluded data (e.g., is exclusion likely to reduce/eliminate coverage in a particular sub-region)
  - b. Explain how the original authors addressed missing data and details about any interpolation procedures used by the authors.
  - c. Describe any sample weighting that was used in the original study. Separately identify an spatial component used in the weighting scheme.

**Variables:** Describe the variables used in the original study to address the research questions and hypotheses that are the focus of the replication.

1. Identify any experimentally manipulated variables and include details about how these variables were manipulated during the original study.
2. Identify any measured variables examined in the original study
  - a. Identify both the response(s) and predictor variable(s) associated with each hypothesis

- b. Describe any variable transformations (e.g., log-scaled, categorical)
  - c. Describe any spatial aggregation/disaggregation that was applied to any variables
- 3. Describe any adjustments made to the variables to account for
  - a. first-order spatial effects (sub-regional differences in means)
  - b. second-order spatial effects (spatial dependencies)
  - c. spatial anisotropies (directional trends)

**Analytical Specification:** Describe the exact analytical specification that was used to test each hypothesis

- 1. For computational studies include information about the hardware and software environments of both the original study
- 2. Identify the coordinate system(s) and projection(s) used during the original analysis
- 3. Specify if/how edge effects were addressed. Provide details regarding the extent of any buffer or guard areas used.
- 4. Describe the type of model, the specification of that model, distributional assumptions of the model, and any post-hoc analyses used to test each hypothesis. Key aspects of some common geographical analyses include:
  - a. If a spatial weighting scheme was used, provide a functional description of that scheme
  - b. If a spatial model was used, provide detailed description of that model
  - c. If a classifier was used, provide details about the selection of training data, validation data, and if any independent test data
  - d. If a spatial multi-level model was used, identify the spatial scale of each level, the variable included at each level, and the levels any spatial structures or cross-scale structure are estimated at.

**Inference Criteria, Results, and Robustness:** For each separate hypothesis, provide a description of the results of the original study and the relevant inference criteria and robustness checks

- 1. Describe the specific criteria (e.g., *p*-values, effect size, model fit) and thresholds that were used to make inferences.
  - a. Identify any adjustments made for multiple testing (e.g., Bonferroni, Sidak) and how they were implemented.
- 2. Describe the result associated with each hypothesis.
  - a. Identify the size and direction of the effect, measure of variance of the effect, statistical assessments
- 3. Describe any robustness checks that were completed to assess the strength and reliability of inferences for each hypothesis. Identify any spatial components varied during robustness checks.

## **Materials and Procedure**

Describe how the replication study will be implemented and identify any materials and procedures used to complete the replication.

- 1. For computational studies include information about the hardware and software environments of both the original study and the replication attempt.

**Protocol:** Explain how the analysis of the replication will proceed and identify if the analysis plan will match the original study. For many replications this section may be quite short if the procedures used in the original analyses are followed closely. In those cases, this section can simply explain how key elements will be followed.

**Differences from the Original Study:** Identify any ways in which the replication is planned to depart from the original study -- a) location, b) sampling, c) data, d) measures/variable construction, d) analytical techniques.

- 1. Provide the motivation for each change that is made to the original study.
- 2. State how the differences identified above may influence the expected size/direction of the effect of the original study

3. List any testable hypotheses associated with each change. If a hypothesis is directional, state the direction
4. Outline any initial analyses that were taken to assess whether the differences identified above will influence the outcome of the replication attempt.

**Assessment Criteria:** Identify the criteria that will define whether the replication attempt was successful (e.g., matched statistical significance, direction of effect, similar magnitude of effect)

## **Replication Results**

For each hypothesis examined, present separately the results of the replication attempt.

1. Briefly describe how the replication protocol outlined above was implemented reporting key information (e.g., sample size).
2. State whether the original hypothesis was or was not supported by the replication
  - a. Provide key statistics produced by the replication.
  - b. Provide key measures (e.g., matching effect direction/size, significance) used to make the decision.
  - c. Highlight any contradictory results with a brief explanation
3. State whether any hypothesis linked to a planned deviation from the original study was supported. Provide key statistics and related reasoning.

## **Unplanned Deviations from the Protocol**

Identify and describe any unplanned deviations from the original replication protocol that occurred during the course of the replication. Explain the rationale behind any deviations. Finally, provide the details and results of any sensitivity analyses conducted to assess whether these deviations may have impacted the results of the replication.

## **Discussion**

Provide a summary of the key findings of the replication along with any limitations or areas in need of further investigation. If the attempt was a failure, discuss possible causes of the failure. *Practical Causes* – related to lack of data, code, details in the original analysis; *Informative Causes* – related to absence of effect, change in population, or location.

## **References**

Include any referenced studies or materials

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